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Auth: CG, ATSC
13 Sept. 1945
By Walter W. Brown, Jr.
Asst. Chief, Special Project Laboratory

MEMORANDUM REPORT

TSERR2C-67

ARMY AIR FORCES
AIR TECHNICAL SERVICE COMMAND
WRIGHT FIELD, DAYTON, OHIO

RAZON ANTENNA AS-254/ARN-38

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MEMORANDUM REPORT ON

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Date 12 July 1945

SUBJECT: Razon Antenna AS-254/ARW-38.

OFFICE Special Projects Laboratory. Contract or Order No. 1061-DAY-45

SERIAL NO. TSERR2C-67 Expenditure Order No. _____

A. PURPOSE:

1. To develop an antenna system for use with the AN/ARW-38 transmitter.

B. FACTUAL DATA:

2. Description:

a. The AS-254/ARW-38 antenna consists of a balanced dipole mounted underneath the aircraft to provide a horizontally polarized pattern for Razon radio controlled bombs. The antenna is designed to cover the frequency range 65-93 mc by adjusting the dipole lengths according to the calibration engraved on the dipole rods. The antenna was designed for narrow band operation, being matched to an unbalanced 50 ohm feed line within a 1.2:1 standing wave ratio at the correct calibrated setting. Although not designed for broad-band operation, a bandwidth of 2 mc is obtained within a 2:1 standing wave ratio at the low frequency setting and at the upper frequency setting approximately 6 mc is realized.

b. The antenna consists of two adjustable dipole rods, varying from 26 1/4 to 40 inches in length, a balance and matching transformer thru which the antenna is fed, two wooden supporting struts, and three mounting bases. These components are shown in the photograph in the appendix. The antenna is mounted with the three streamlined supports along the axis of the aircraft to minimize air drag. A 4:1 fineness ratio is used in the supporting elements and provides acceptable aerodynamic characteristics well over 400 m.p.h. The mounting bases are clamped between channels anchored at each end to cross members of the aircraft structure as well as being rigidly rivetted to the aircraft skin thru a doubler plate. The mounting bases are sealed

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to the skin of the ship by rubber grommets for use in pressurized sections of heavy bombardment aircraft. A B-24 mock-up installation is shown in the photographs.

c. The dipole is mounted 15 inches from the skin of the aircraft to provide maximum clearance as well as rigidity of mounting. This distance is approximately 8% of the wavelength at 65 mc., but is sufficiently great to provide a radiation resistance in excess of 20 ohms at the lower frequency limit. This resistance is matched to the feed line thru the balance and matching transformer resulting in a power transfer efficiency of approximately 95% when set at the correct dipole length shown by the calibration.

d. The antenna is capable of handling 500 watts in continuous operation. The only limitation in power handling capacity is the SO-239 connector and RG-8/U cable within the balance and matching transformer. RG-8/U cable is nominally rated at 480 watts at 200 mc.

3. Production Status:

a. The antenna system is being manufactured by Rowe Industries, Toledo, Ohio, in quantity production under contract 1061-DAY-45. Final tests and acceptance of a prototype model were completed on 8 May 1945.

4. Balance and Matching Transformer:

a. The balanced dipole antenna is connected to an unbalanced transmitter thru a balance and matching transformer. The balance transformer schematic is shown in Fig. 4. A conventional balance to unbalance transformer is used but is cut to very much less than the usual quarterwave length to provide for matching the antenna impedance to the 50 ohm feed line. The admittance of the antenna measured at the dipole leads is shown in Fig. 1. The matching stubs, which also provide for balance from an unbalanced feed line, are in parallel with the antenna so do not affect the conductance, and the lengths are so chosen as to match as nearly as possible 50 ohms (conductance equals 2.0×10^{-2} mhos) over the entire band at the correct calibrated dipole lengths. The matching stubs are fixed and only the antenna dipole length requires adjustment for optimum match to the feed line. From Fig. 1 it will be noted that the final impedance match is within a 1.2:1 s.w.r. over the band at the calibrated dipole lengths.

b. Figure 2 shows the self-impedance of the antenna which has

been calculated from the measured data of Fig. 1 by subtracting the susceptance introduced by the stubs of the balance and matching transformer. The radiation resistance is shown and varies from approximately 22 to 35 ohms over the band.

c. Figure 3 shows the calibration curve and corresponding crystal code at the optimum dipole settings for best impedance match over the frequency band. The dipole rods have been engraved with the transmitter crystal code and it is then only necessary to check the crystal to set the proper dipole length before tuning up the transmitter.

5. Radiation Patterns:

a. Figures 5 thru 8 show the antenna patterns on a B-24 mock-up installation. The balanced dipole provides an optimum pattern for radio controlled vertical bombs such as Razon. Maximum radiation occurs directly beneath the aircraft which is essential for efficient control. The pattern across the wing axis is much broader than the fore and aft pattern so it is possible in some installations to vary the mounting position as much as 15 degrees from the bottom center line. However, the antenna should be mounted as nearly horizontal as possible since the fore and aft pattern is more restricted.

C. CONCLUSIONS:

6. The AS-254/ARW-38 antenna system is satisfactory for operation with radio control transmitter AN/ARW-38 over the frequency range 65-93 mc.

7. The antenna is matched to a 50 ohm unbalanced feed line within a 1.2:1 s.w.r. at the calibrated dipole setting which corresponds to the transmitter crystal code.

8. The matched antenna is broad-band enough to operate in limited broad-band applications, and the impedance will be affected only slightly in different mounting locations, providing the antenna is mounted on a reasonably flat surface comparable to the location selected on the B-24 aircraft as stated in this report.

9. The antenna is designed with favorable aerodynamic characteristics up to 450 m.p.h., and is provided with pressurization seals for heavy bombardment aircraft.

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10. The antenna system is capable of handling 500 watts power in continuous operation at 95% efficiency and is limited in power handling capacity only by the SO-239 connector and RG-8/U cable used in the balancing and matching transformer, RG-8/U cable being nominally rated at 480 watts at 200 mc.

11. The radiation patterns are ideally suited for control of vertical bombs, maximum radiation occuring directly beneath the aircraft. The pattern is wide enough across the wing to permit mounting up to 15 degrees from the bottom center line, but should be kept as nearly horizontal as possible along the fore and aft axis of the aircraft.

D. RECOMMENDATIONS:

12. It is recommended that the antenna be mounted at least 10 feet away from a horizontal wire antenna of comparable length such as the fixed-wire marker beacon or communication antennas.

13. It is recommended that final tuning of the transmitter be accomplished in flight as ground tests indicate that the impedance of the antenna is sufficiently affected by the proximity of the ground to change the transmitter tuning.

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APPENDIX I.

Fig. 1 Antenna Admittance

Fig. 2 Antenna Self Impedance

Fig. 3 Calibration Curve & Crystal Code

Fig. 4 Balance and Matching Transformer

Fig. 5-8 Antenna Patterns

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APPENDIX II.

Photographs:

(1) Antenna Assembly

(2) Installation B-24 (exterior view)

(3) Installation B-24 (interior view)

Drawings:

(1) Assembly drawing

(2) Cross-sectional drawing

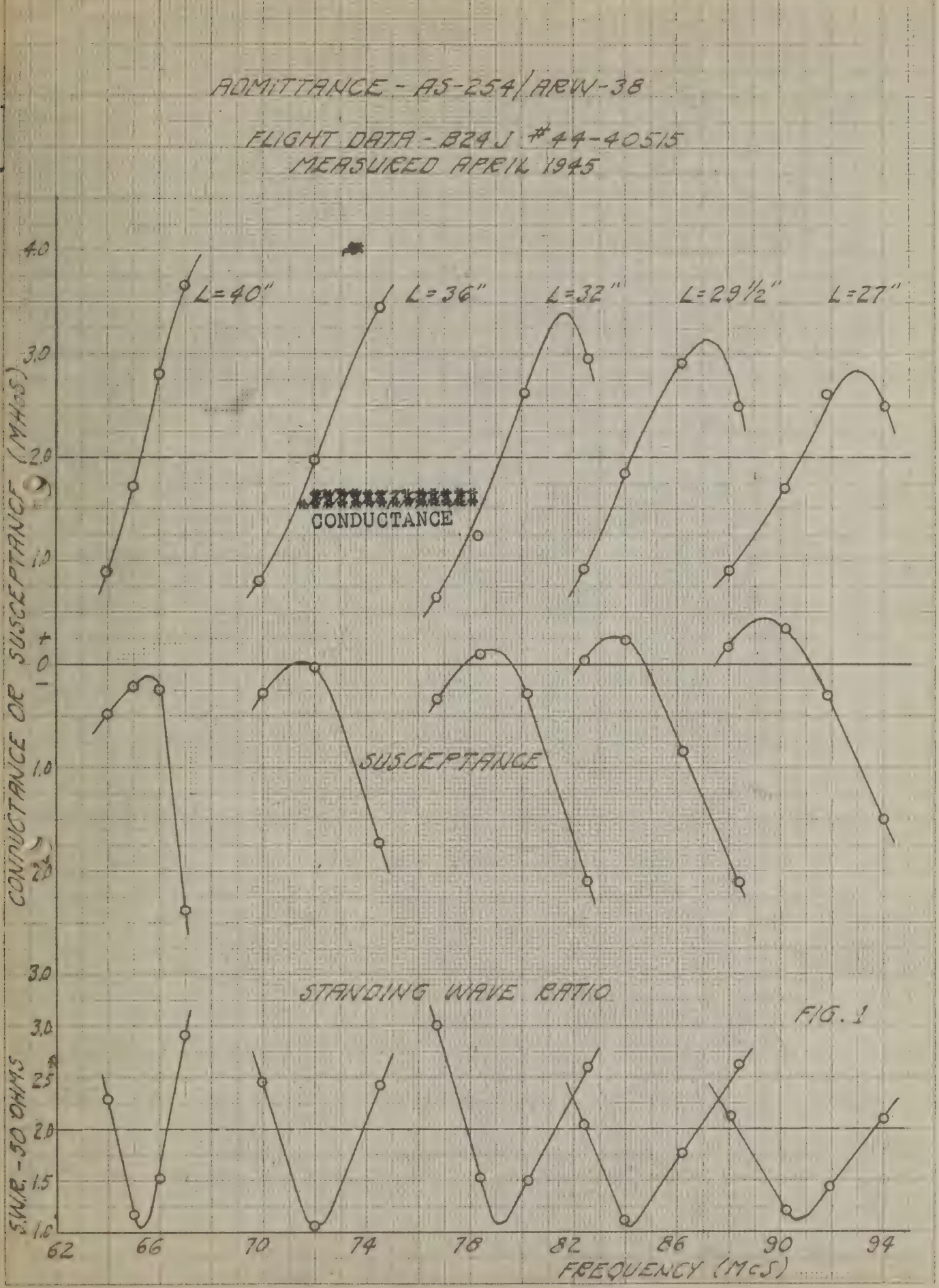
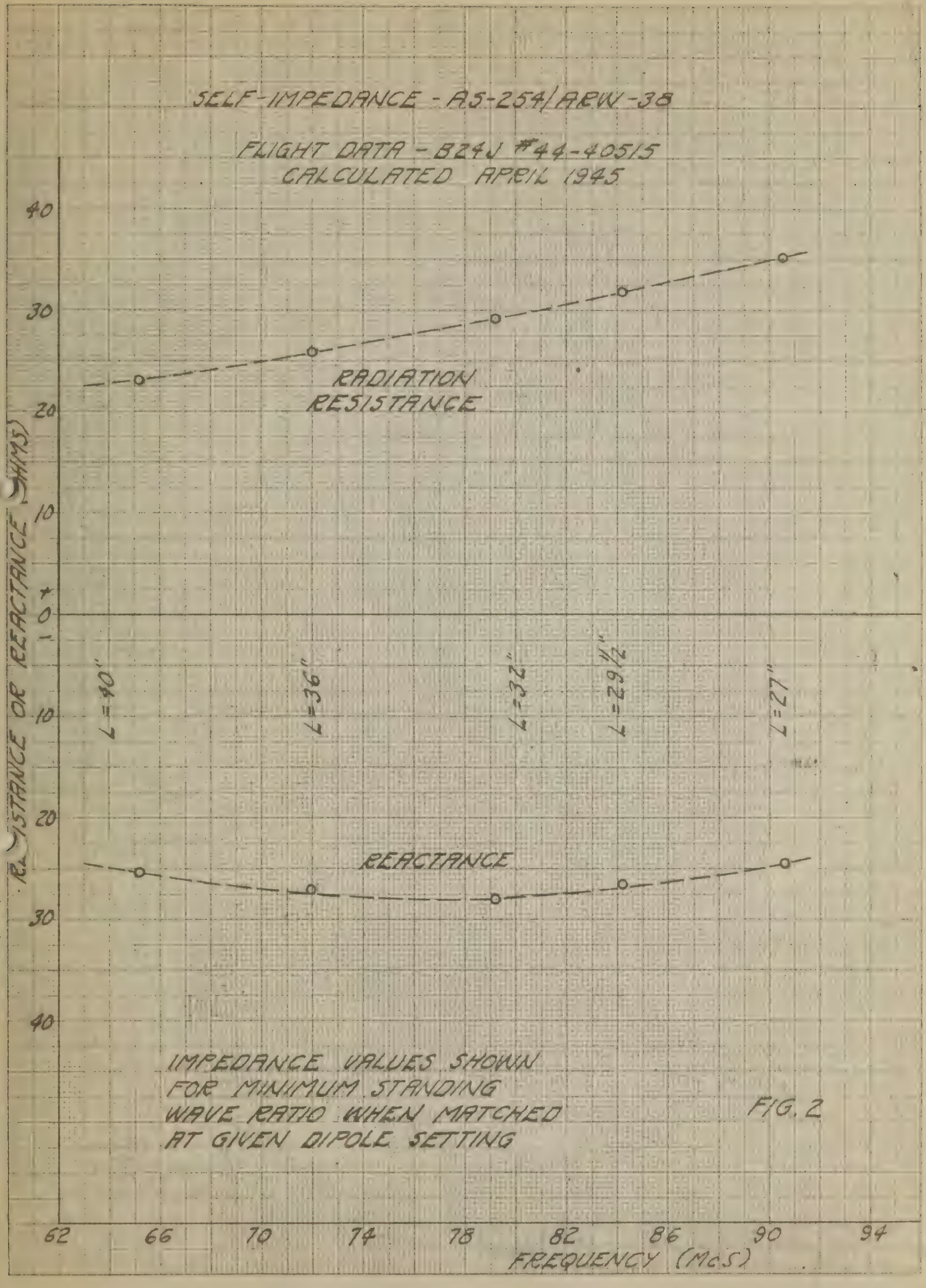
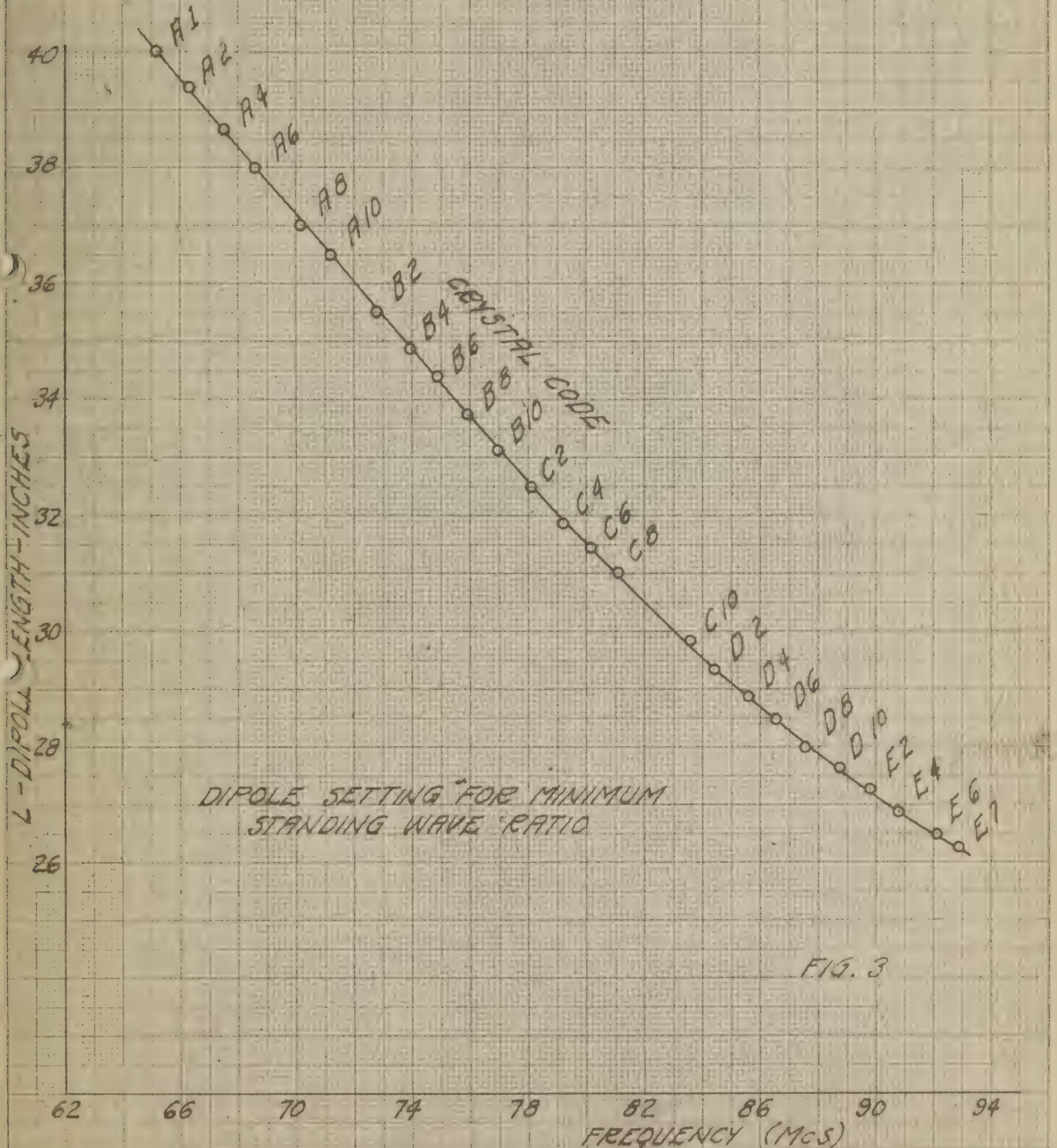

ADMITTANCE - AS-254/ARW-38
FLIGHT DATA - B24J #44-40515
MEASURED APRIL 1945
L=40"
L=36"
L=32"
L=29½"
L=27"
CONDUCTANCE
SUSCEPTANCE
CONDUCTANCE OR SUSCEPTANCE (MHOS)
4.0
3.0
2.0
1.0
+
0
-
1.0
2.0
STANDING WAVE RATIO
3.0
3.0
2.5
2.0
1.5
1.0
S.W.R. - 50 OHMS
62
66
70
74
78
82
86
90
94
FREQUENCY (MCS)

FIG. 1


SELF-IMPEDANCE - AS-254/ARW-38
FLIGHT DATA - B24J #44-40515
CALCULATED APRIL 1945
RADIATION RESISTANCE
REACTANCE
L=40"
L=36"
L=32"
L=29½"
L=27"
RESISTANCE OR REACTANCE (OHMS)
FREQUENCY (MCS)
IMPEDANCE VALUES SHOWN FOR MINIMUM STANDING WAVE RATIO WHEN MATCHED AT GIVEN DIPOLE SETTING
FIG. 2

CALIBRATION CURVE - A5-254/ARW-38

FLIGHT DATA - B24J #44-40515
MEASURED APRIL 1945



DIPOLE SETTING FOR MINIMUM STANDING WAVE RATIO

FIG. 3

BALANCE AND MATCHING TRANSFORMER - 95-254 / ABM-38

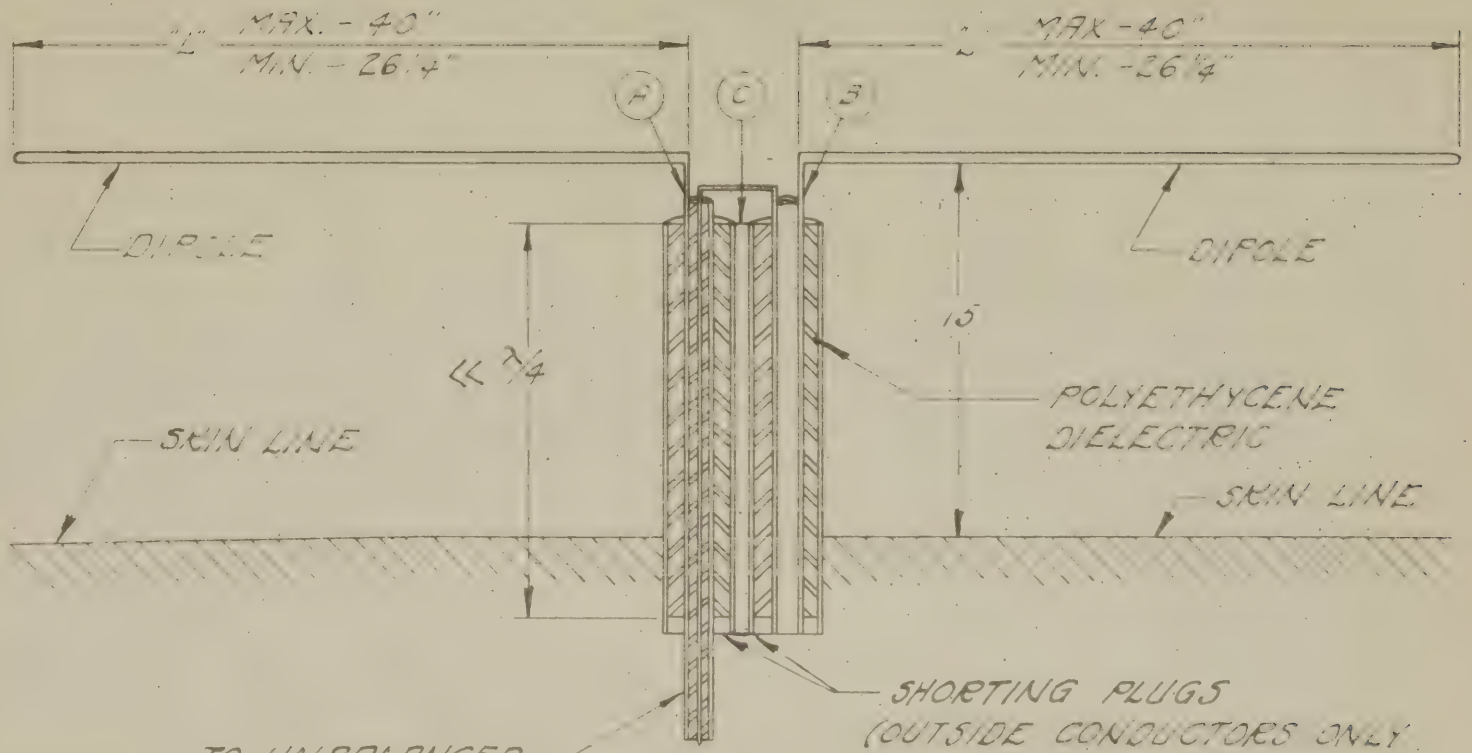
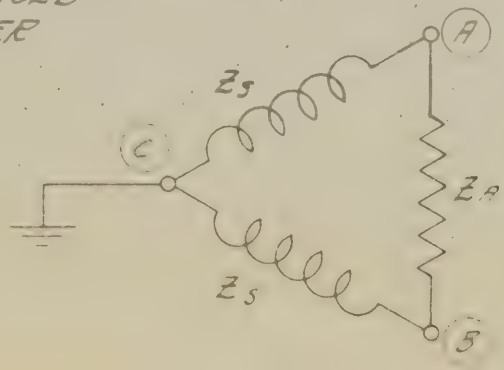


FIG. 4



EQUIVALENT CIRCUIT OF BALANCED LOAD

Z_A - ANTENNA IMPEDANCE

Z_S - LOADING REACTANCE

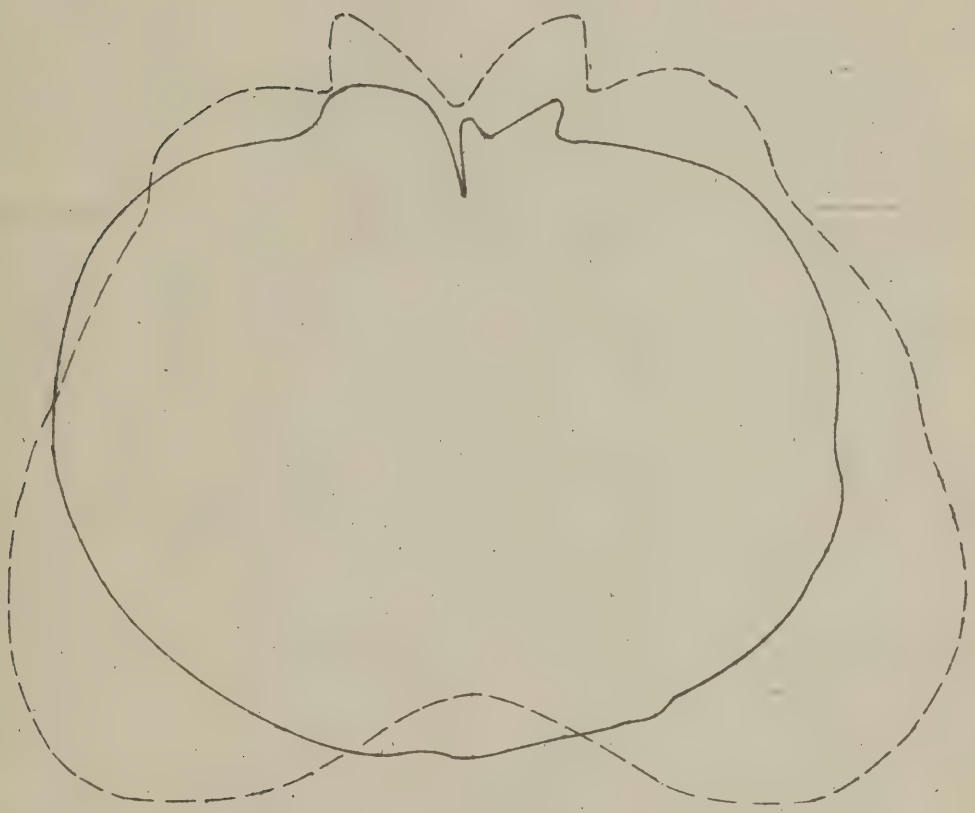


FIG. 5

NOTE: SIGNAL MAGNITUDES NOT COMPARABLE

B24
1/30 SCALE

AS-254/AEW-38

65 & 75
1950 & 2250
65 Mc
75 Mc
6-29-45

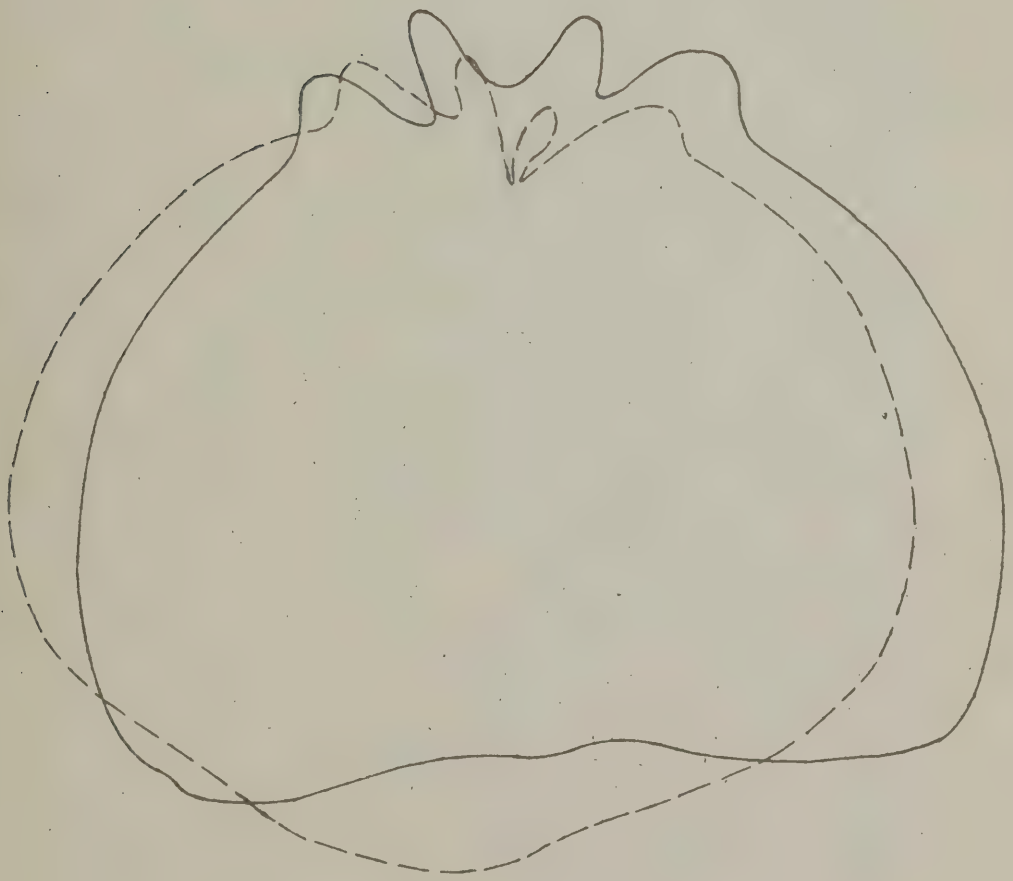


FIG. 6

NOTE: SIGNAL MAGNITUDES NOT COMPARABLE

B24
1/30 SCALE

AS-254/ARW-38

85 & 95
2550 & 2850

85 Mc
95 Mc

6-29-45

FIG. 7

NOTE: SIGNAL MAGNITUDES NOT COMPARABLE

824
1/30 SCALE

AS-254/ARW-38

FREQUENCY 65 & 75
SPACE ATTEN. 1950 & 2250
65 MC.
75 MC.
6-29-45

FIG. 8

NOTE: SIGNAL MAGNITUDES NOT COMPARABLE

B24
1/30 SCALE

AS-254/ARW-38

85 & 95
2550 & 2850
85 Mc.
95 Mc.
6-29-45

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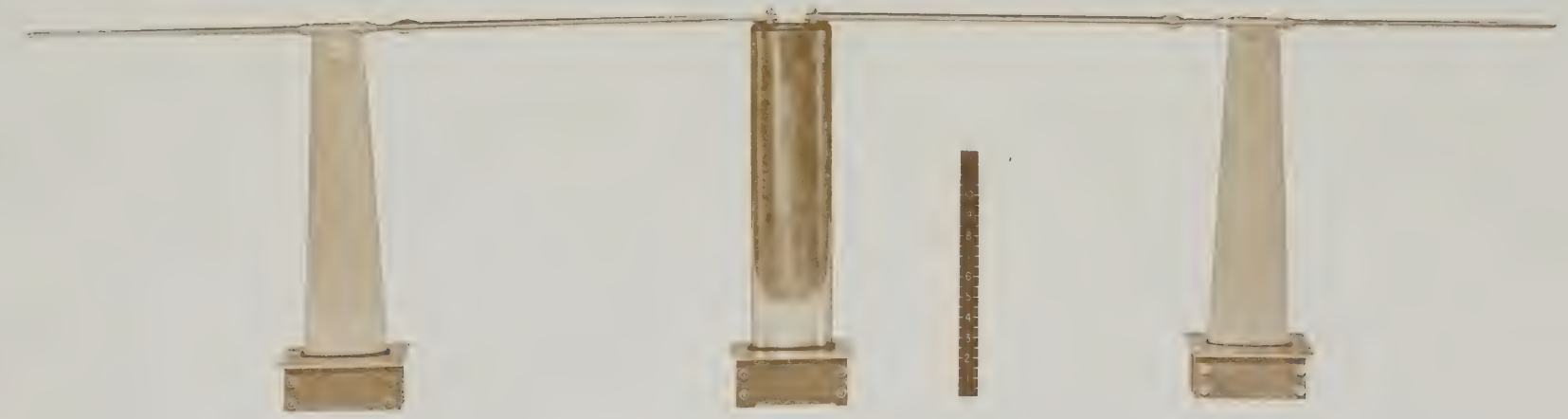

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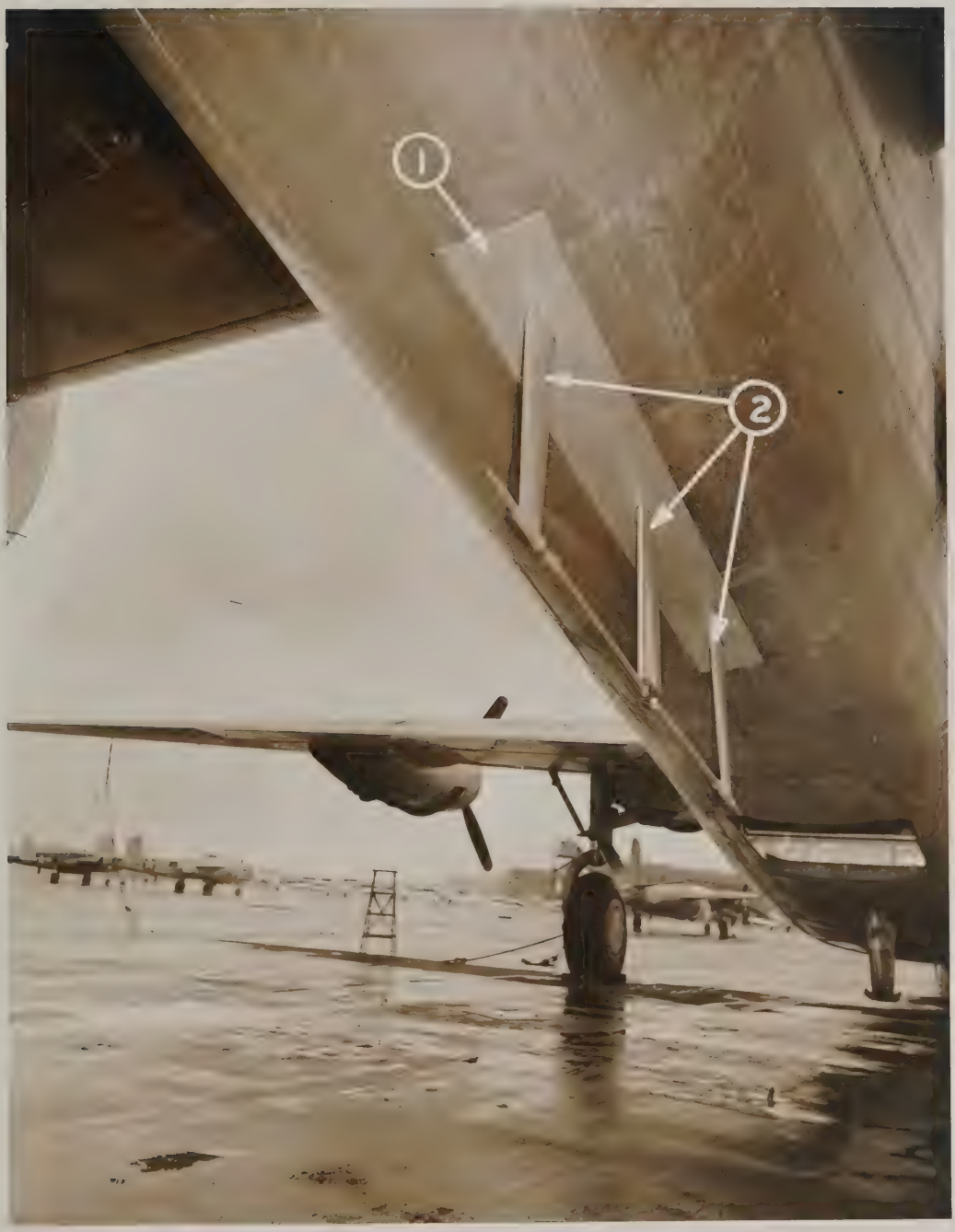

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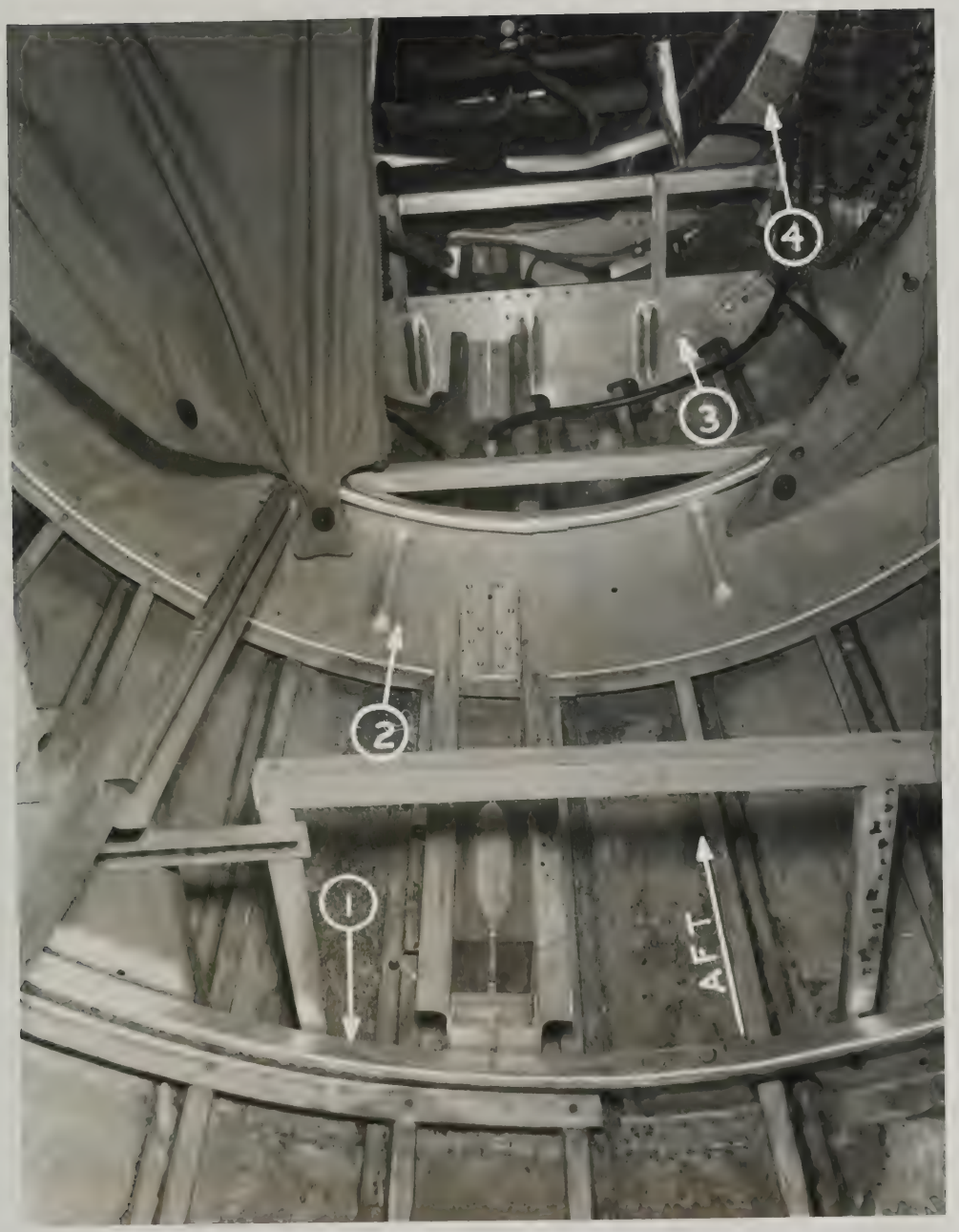

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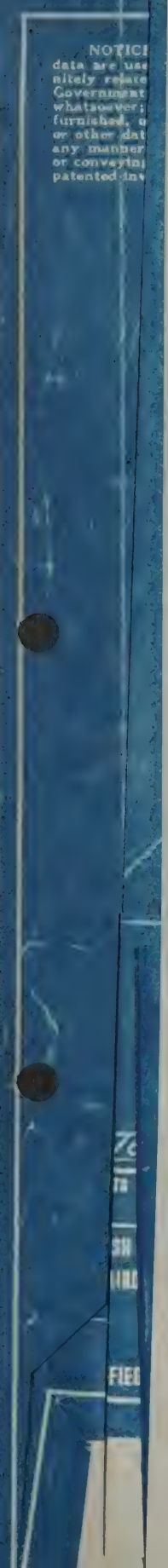
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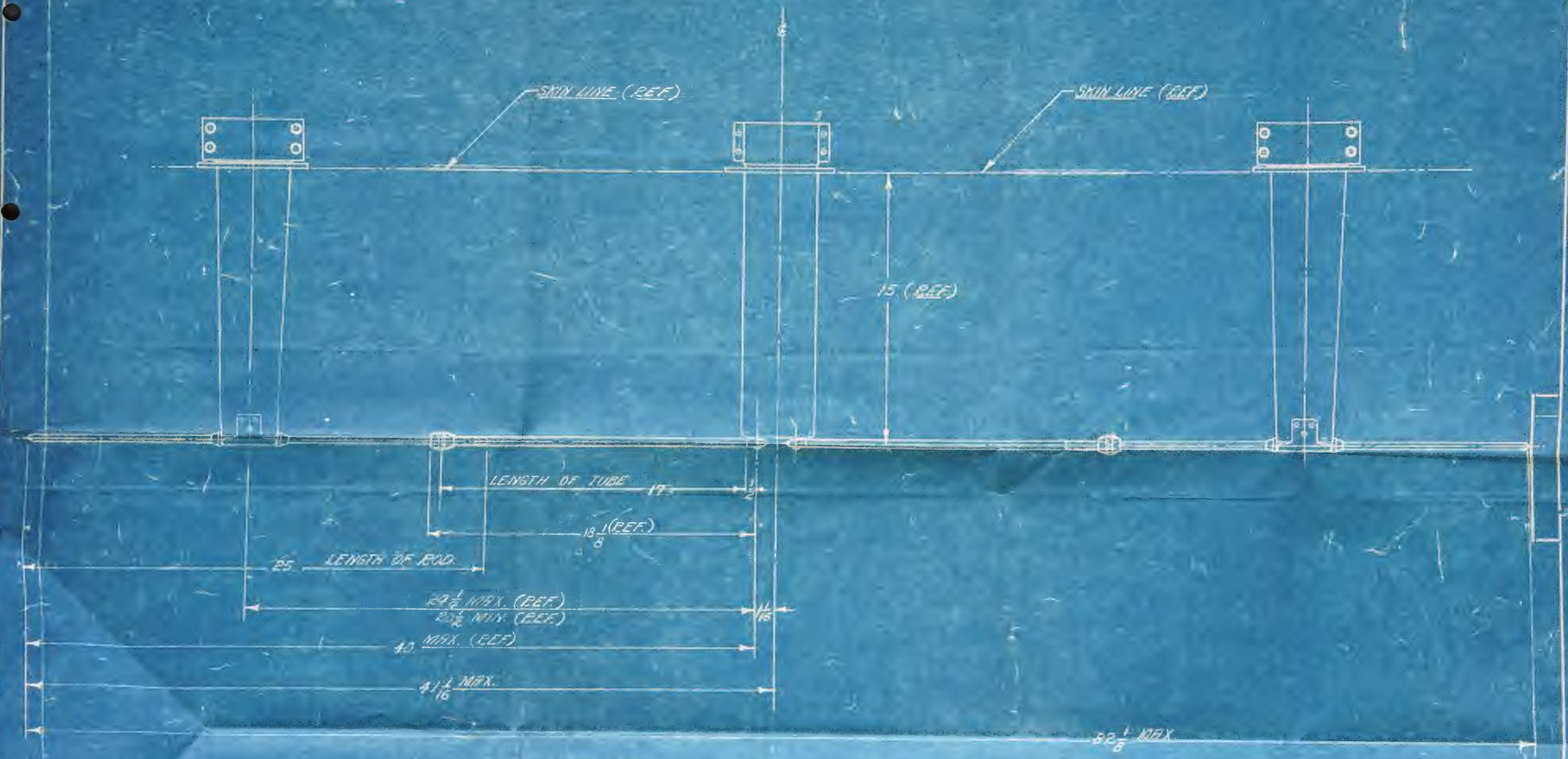

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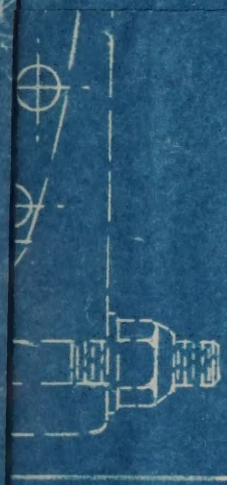

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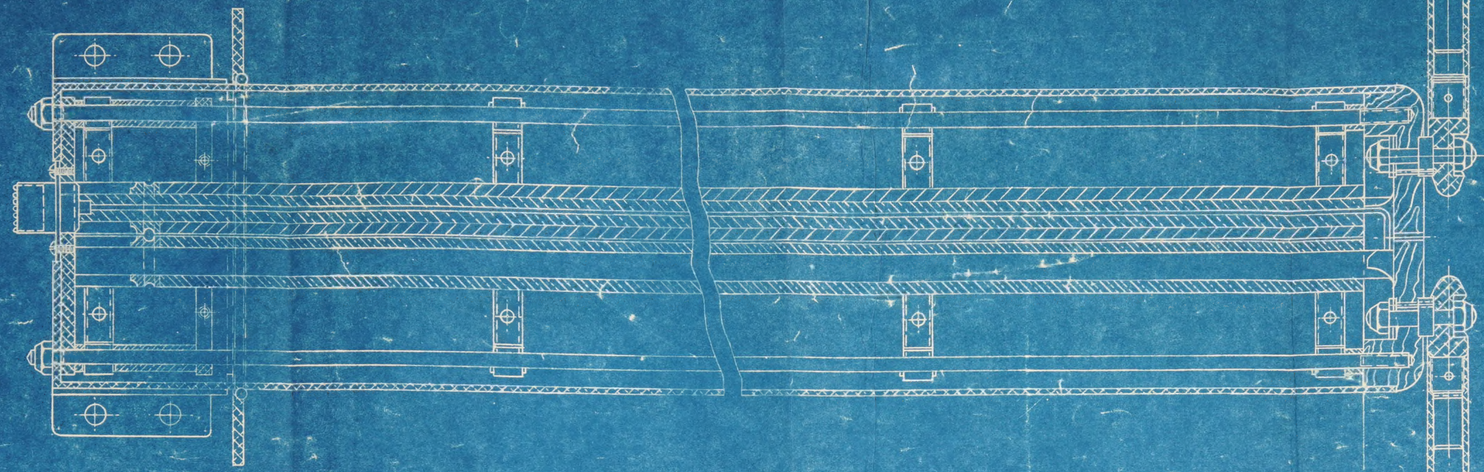

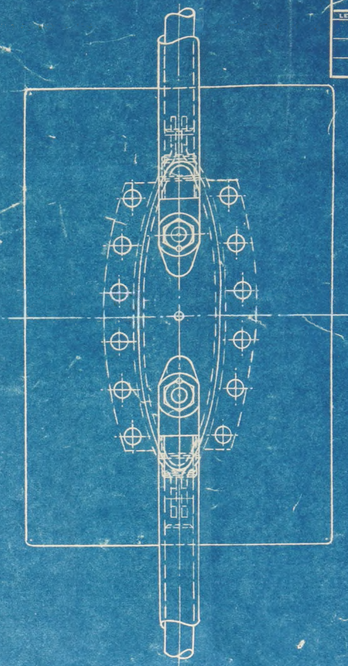

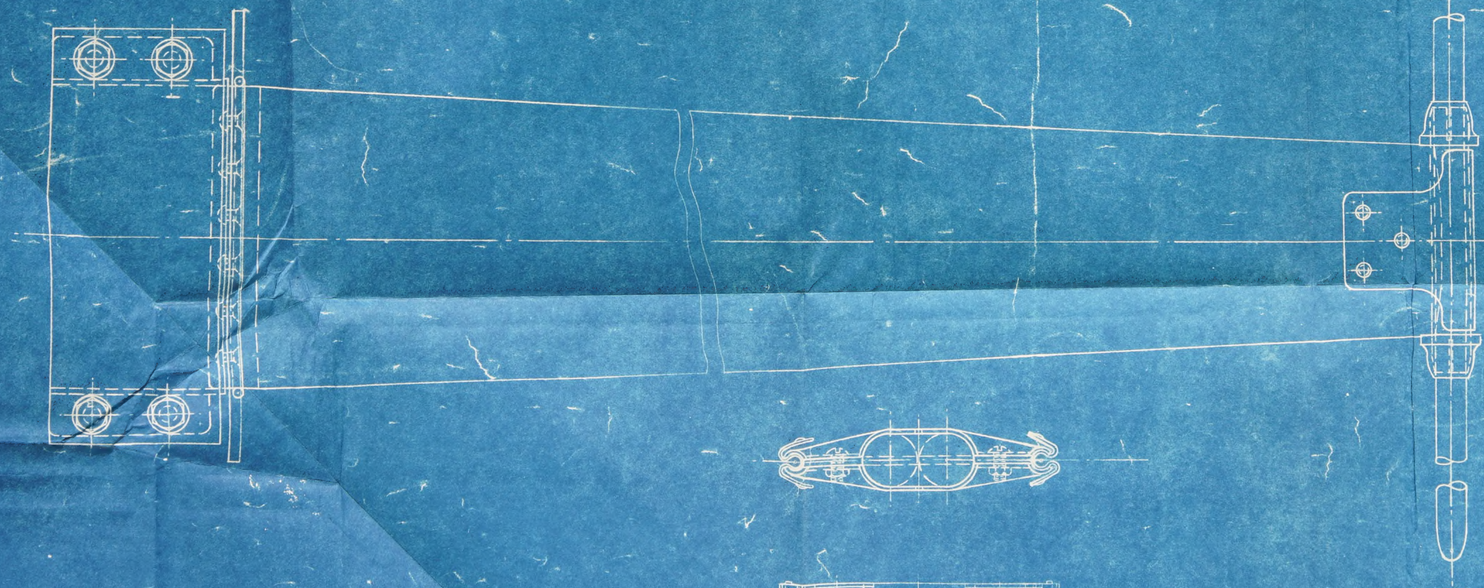

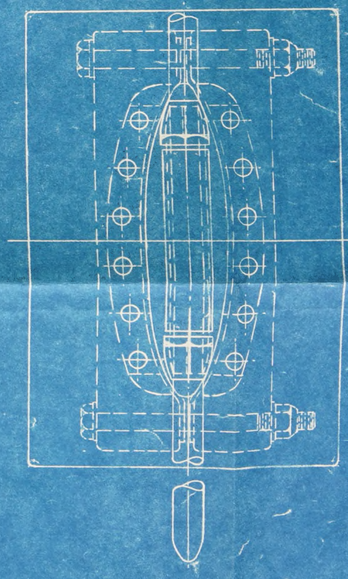

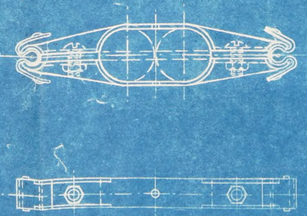

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